AVAILABILITY OF INFORMATION AND MEANS OF TRANSFER

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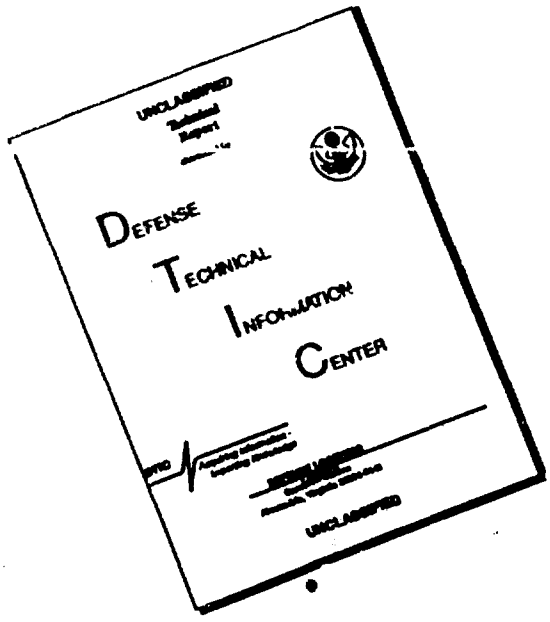

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AVAILABILITY OF INFORMATION AND MEANS OF TRANSFER

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Technical information is a vital commodity at General Electric's Missile and Space Division. I have been asked to discuss how we handle this information, how a computerized system retrieves it, and how the Library interacts with the 12,000 scientists, engineers, and supporting personnel who are our customers.

Before discussing information handling, I would like to describe the organizational structure of the Missile and Space Division as a means of illustrating the diversified technologies encountered. MSD is comprised of the following major components:

Re-Entry Systems Organization - concerned with guided missile technology, re-entry vehicles and systems (such as Minuteman), space re-entry systems (such as the NASA biological experiment), and classified strategic programs.

Space Systems Organization - has responsibility for space programs, such as the NIMBUS weather satellite for NASA and other satellites, as well as stabilization systems, systems analyses, and mission feasibility studies.

Space Sciences Laboratory (of which the MSD Library is a part) - performs both pure and applied research in support of existing programs throughout the Division as well as performing direct contract work on MHD power generation, plasma propulsion, nuclear and particle impact phenomena, re-entry observables studies, space and planetary environment measurements, and development of high-temperature, high-strength structural materials.

In addition, many of our operating components are involved in non-defense work and non-space work: including oceanography, systems applications for hospitals, mathematical models for medicine and biology, and materials development, with specific interest in composite materials.

The Division also operates the Apollo Systems Department, at Daytona Beach, Florida, for integration and testing of the Apollo lunar program and the Mississippi Test Support Department at Bay St. Louis, Mississippi, where extensive facilities are maintained for testing the SATURN booster, which will provide the propulsion for the APOLLO.

This will give you some idea of the work commitments of our Division, and the types of technological data needed to support a large and complex research and engineering program.

This brings me to my main theme: the availability of technical information and means of transfer.

The MSD Library provides an essential service in acquisitioning, cataloging, storing, and supplying technical information to almost 12,000 users. This is accomplished by 3 library units who maintain a collection of about 65,000 bound volumes and close to half a million documents.

The mission profile of the MSD Library can be summarized as follows:

- Lend technical books
- Acquire and select those books and journals which meet the business picture of the Company
- Answer reference questions by phone, in person, or by letter
- Perform literature searches in depth by both our own computerized information retrieval program and the services offered to the space community by NASA and the Defense Documentation Center
- Compile, on our own initiative, definitive report bibliographies and biblioabstracts

- Provide a source of secondary distribution for our Division-generated TIS (Technical Information Series) reports
- Verify factual information
- Act as a central source within the Division for all book acquisitions and subscriptions
- Perform or arrange for the translation of foreign language technical articles or technical reports (In our Library we have flexibility in Russian, Spanish, German, French, Hebrew and Italian.)

New books are announced by a Book Bibliogram notice. We have also used the Company newspaper to reach as many technical personnel as possible. We are currently subscribing to about a thousand different journals. New documents are promptly announced by means of a classified and unclassified Technical Abstracts Bulletin, which is disseminated widely.

An excellent source for keeping the technologist currently aware in the avalanche of technical information which engulfs him is the Defense Documentation Center's TECHNICAL ABSTRACT BULLETIN, oriented toward military research and engineering programs.

NASA has done a superb job, in producing two information indexes, and, in my opinion, is the leader in the game of Information Retrieval in the U.S. NASA's STAR, an acronym for Scientific and Technical Aerospace Reports, covers report literature in depth. It is well organized, indexed by author, subject, corporate source (originating agency), and even by contract number. Annual indexes are published summarizing the contents of the preceding 24 issues. Simultaneously, the American Institute of Aeronautics and Astronautics, under the direction of my friend, John Glennon, publishes the International Aerospace Abstracts. This publications compliments the STAR, in announcing and abstracting "open literature" material, professional society papers, books, significant journal articles, thereby giving the researcher virtually complete coverage in aerospace technology. Both AIAA and NASA deserve the cheers from aerospace librarians and the engineer.

Since the General Electric Company/MSD Library is a special library for collecting and transferring technical information to its users in aerospace disciplines, I would like to discuss for a moment a truly forward movement in assisting the engineer seeking to keep current in his particular technology, I am referring to the NASA/SCAN Program, wherein we are cooperating with the NASA Scientific and Technical Information Division. SCAN is an acronym for Selected Current Aerospace Notices. It is a novel quick-reaction information system originated by NASA/Scientific & Technical Information Division. The goal of NASA and all aerospace libraries and information centers participating in the SCAN Program is to provide its users with rapid notification of the latest aerospace reports and journal articles on SPECIFIC subjects that are likely to be of interest to them. Essentially, this saves a busy engineer from scanning many indexing tools. For instance, an engineer interested in display systems and human engineering will select only those categories--and timely data will be in his hands, especially since the SCAN participant has the microfiche copy available. We determine the engineer's field of interest, we notify the NASA/SCAN office what that interest is, the engineer reviews the SCAN notice, title, author, abstract, report number, checks off which item on the page is of significance, and the Library, in turn, provides immediate data. The items include both AIAA and STAR publications.

The MSD Library maintains the entire NASA/STAR series of reports on microfiche. From the American Institute of Aeronautics and Astronautics the SCAN notices covering the open literature are promptly available. Thus in the area of space technology, the MSD Library is the retailer of technical information. NASA and AIAA are the wholesalers, so to speak, and our General Electric scientists and engineers are the buyers. And the buyer or library user is the most important element in utilizing new technology.

Since the Missile and Space Division has numerous military contracts, I would like to emphasize the services of the Defense Documentation Center, popularly known as DDC. In essence, DDC performs the same function as

NASA/STID and AIAA for the military community and its contractors. The DDC Technical Abstracts Bulletin is the major announcement media for classified documents and unclassified documents, which are limited in distribution to military agencies and DOD contractors. Field-of-interest registers are filed with DDC for each contract our Division receives. This entitles the DDC user to the complete services of (1) Copies of the DDC Technical Abstracts Bulletin (2) The CFSTI US Government Research Reports (announcing documents accessible to the public domain), (3) Hard copies of documents or microfiche, if we prefer, and (4) Computerized literature searches.

The last service I mentioned is also available to contractors of NASA, which has done a yeoman's job in meeting a Sissyphus type demand for computerized searches. Both DDC and NASA perform computerized searches for qualified users, within the security limitations of our contracts. This bibliographical service is invaluable to the engineer both from the viewpoint of timeliness and specificity. The engineer needing this type of service consults with our Library staff. We obtain the scope of his problem and then, utilizing the thesauri of NASA and DDC, we prepare our search question. The secret in obtaining good results in a bibliographical search is for the engineer and the librarian to decide on a common language and, once the communications barrier is down, DDC and NASA can interpret the engineer's needs.

Rounding up the theme of my paper of availability of information and means of transfer, I will devote the balance of my time to our own General Electric/MSD Random Access retrieval system, commonly known as "on-line searching". Our document collection, numbering about 290,000 documents, represents one of the largest bases of technical information in the aerosapce community. And it is growing at the rate of 23,000 documents per year! About 8 years ago our Library staff and GE/MSD management realized that information is a valuable corporate resource only if it can be retrieved. How do you go about finding an obscure experiment analyzed in a Technical

Memorandum 5 years ago, and which suddenly becomes hot or critical? And, of course, no one has copies of the report, they can't remember the author, they are hazy about the date; all the information which the poor frustrated engineer can give the Library is that it was a report about 15 pages long and dealt with shock waves and shock wave effects of a blunt body in a rarefied flow environment. Now - this is where the MSD Library services pay off. Utilizing a real-time, on-line retrieval system, the descriptors

shock waves
blast waves
gas flow
rarefied flow
blunt bodies
flow characteristics

are typed in on the desk side teletype computer in the Library. The configuration might look something like this:
(Blunt bodies/ReEntry Vehicles/Bodies of revolution(*
(Shock effects/blast waves/rarefied flow/Gas flow/Shock waves)

The computer memory disc rapidly selects those documents which match the equation. The result is a 20-second printout of all the documents which answer the question. The searcher then narrows down the terms, if he has not located the document which he is seeking on the first run.

Since the computer is mathematically oriented, it follows that a solution to retrieval problems in a large data bank should have a foundation in mathematics. By using Set Theory, we took advantage of its basic flexibility, which provides alternatives to the engineer or librarian doing the literature search, while remaining sufficiently restrictive to minimize the "noise factor". It has been our experience in the past six years that, even with the finest mechanization system the engineer or designer can create, the value of the information retrieved is directly independent on the indexing skill and the consistency of the descriptors used. We have prepared our own specialized Thesaurus, with suitable cross references, tailored to meet the

needs of a multi-disciplined research and engineering organization. At the present time there are roughly 14000 descriptors and identifiers and the collection of actual documents is well over the 250,000 mark.

A computerized search will yield a print-out of the accession numbers in the Library's file which answers the requestors needs. Typical examples of requested information which the computer can handle are:

- The pressure in the wake of a re-entry vehicle from supersonic to hypersonic speeds
- Heat transfer and thermodynamic properties of composite materials, with specific interest in boron carbides.
- Wind tunnel test results of the APOLLO where Mach number 18 speeds are essential
- Photographic spectrometry and radiometry on distant field sources.

A configuration or query given to the computer for searching is composed of descriptors or identifiers (key projects, specific hardware, etc.) and set theoretical relationship. We consider all those accession numbers that meet the conditions specified by the search request to be a set. We term this set of accession numbers the "Solution Set". The elements of a solution set are always determined by the relationship of the descriptors and identifiers. In essence, search strategy is concerned with three set theoretical relationship, intersection, union and negation.

Prior to programming a computerized search, the Librarian or the user has a choice of the following three conditions:

(a) The intersection of two sets, A and B, is the set of all elements common to both set A and set B. We use a plus sign to symbolize intersection: A + B.

(b) The union of two sets, A and B, is the set of all elements which belong to either set A, or to set B or to both sets A and B. We emply a slash sign to symbolize union: A/B

(c) The negation of set A by set B is the set of all elements which belong to set A but not to set B. We symbolize negation by a minus sign: A-B

For those interested in the way the computer works, let me briefly describe random access retrieval or on-line retrieval. From the descriptors key-punched by the librarian on a typical 80 column card, the data is transferred directly into the GE-265 computer memory system or disc storage units. The disc storage unit subsystem is a large capacity, fast random-access storage device for information processing systems. It is a new and vastly flexible filing medium that stores information so that data so recorded in a random location can be immediately returned for further processing.

The Disc Storage Unit subsystem makes it feasible to maintain virtually any business or information file on a current basis, transaction by transaction. The method of random filing and up-dating records has advantages over the necessity of sequencing or batching, in order to update records.

The MSD I ibrary and users of the random access retrieval system can make unbelievably rapid searched; within 20-25 seconds the reply is received, citing the following basic data:

(1) Our Library computer code number

(2) Total number of documents satisfying the request which will meet the search parameters.

(3) A chronological listing (most recently received documents having the higher accession order number) of those documents and publications satisfying the request.

Each subscriber to the MSD Library computer retrieval service receives the thesaurus or vocabulary to design his search configurations. In addition, a cumulative title or abstract printout is furnished to all the users. Once the accession numbers are printed out, it is relatively simple to refer to the printed title catalog. Both the thesaurus and the title

catalog are updated by the computer for timeliness of data received by the Library.

In the early part of 1966, desk side consoles were strategically allocated by management throughout many of the Engineering/Scientific Operations. This included the Philadelphia and Valley Forge areas, and other parts of the Division as far west as California. This was an ideal opportunity to test the system from the user's viewpoint.

The Library thesaurus was distributed on a pilot test basis to two engineering groups for their education and we taught them how to browse in the Library, by remote control, so to speak. We found that the greatest problem in these early experiments was the variance in language used by the librarians and by the technologists. There was a need to wed the jargon, so one could readily communicate with the other. Lexicographic sessions were held by our Library staff with a multi-disciplined engineering organization. This permitted us to streamline the vocabulary. Incidentally, the need for semantic assocation with the user of the system, and for the Library personnel to keep abreast of new technologies affecting his field is of paramount consideration.

Later in May of that year, we assigned a desk side computer console to our Branch Library in mid-city. Fortunately, our librarian is a trained scientist with an empirical approach to the information problem, and she has made excellent use of random access retrieval for almost 2500 engineers in our Philadelphia operations. Engineers at MSD can now search the Library with minimum instructions.

As a by-product of our information retrieval system, we have been given access to the Manpower Information Retrieval system. Based on the MSD Library retrieval method, we have the capability of querying the computer as to engineering talents of GE/MSD employees. This is especially helpful when a customer comes to the Library and needs a 3-page report on nuclear physics translated from the Japanese. We are then able to dial the system and find out who has capabilities to read, write and understand

Japanese plus a knowledge of physics. This type of "latter day CATE system" is invaluable in providing management and the engineering operations with fast information, WHEN IT IS MOST URGENTLY NEEDED.

Because of its research and engineering orientation, the GE/Missile and Space Division ranks its people as a prime asset. As the Division matured, the need arose for an efficient and speedy system of gathering and maintaining information concerning the Division's manpower resources and capabilities--a manpower inventory system which would accomplish several objectives.

First, it would enable engineering management to permit promotion of eligible and qualified employees into extant job opportunities and, secondly, would provide for easy identification of talents within operation, department or division level for manpower planning and contract proposal efforts. For this reason, about eight years ago, concurrently with the MSD Library Information retrieval system, management began seeking a tool which would determine accurately and efficiently the quantity, quality, location and depth of skill resources, capabilities and potential existing in the Division.

A project team of Employee Relations and Information Systems personnel was formed to develop a system which would collect, maintain, update and retrieve extensive information about the Division's professional personnel: namely, a continuing manpower inventory. Realizing the importance of managerial participation, the project team conferred with managers throughout the Division to determine:

a) The kind of information about our professional employees that managers felt should be retrievable.

b) A standard terminology by which professional employees would be able to describe their education, training and work experience.

It was found that managers also wanted to know about memberships in professional societies (such as AIAA, IEEE, ASME, etc), participation in civic and other organizations, patent and invention activity, and positions

for which employees had an interest and believed that they were qualified. This probject resulted in the MIRS (Manpower Information Retrieval System). The system was designed, not to supply management with a group of predetermined reports, but to extract rapidly and accurately, information concerning Division personnel as needs for specific type of talents and capabilities were needed.

Incidentally, the MSD Library utilizes this invaluable MIRS file for our own selective dissemination system of technical information. Data is rapidly transmitted, where the Library knows that it can be used and digested almost the very day it is needed!

The full value of MIRS is achieved only by management's being aware of potential uses of available data to solve problems and to guide policy. General Electric/MSD management participated in the development of this system and continues to give it full and enthusiastic support. Random access retrieval makes it possible for a manager in our Apollo Systems Department in Daytona Beach, Florida, to query the computer on his needs for a new opening in his department for a Quality Control engineer, with 5 years experience in cryogenics; 25 seconds later he can dial the code for the MSD Library--and be able to do a search in cryogenics. This is an example of man/machine interaction in the age of the "information explosion."

Future plans and thinking of our computer operations and MSD Library staff call for transfer of our discs to the much larger GE-605 computer - which will provide a great deal more disc storage space. As time goes on, more and more engineers will learn the value of using the "on-line" system for rapid retrieval of the specific reports they may require. Today we have about 40 plus subscribers to the Library file. In a decade we foresee the means of transferring technological intelligence by more sophisticated hardware and programs. More than likely, looking into the crystal ball, the library searcher will speak to the computer. A recording device will then analyze the descriptors or key words in his query; and the results will be printed or flashed on a screen, in no time flat. We, at the MSD Library

are working hard toward that end ....because the engineer and his information problems are the Library's prime concern.

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